

THE WEATHER AND CIRCULATION OF OCTOBER 1963

Abnormal Warmth and Severe Drought in the United States and Two Unusual Hurricanes Offshore

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1. INTRODUCTION

The weather over most of the United States was remarkably warm in October 1963. Monthly average temperatures were the highest recorded for any October from the Rocky Mountains to the Ohio Valley. The hot weather was persistent, although the area of largest weekly departures gradually advanced from the West to the eastern States during the month. Severe drought conditions accompanied the warmth in a broad area stretching from the Southern Plains to the Northeast. Following the eastward march of the largest positive temperature anomalies, rainfall increased, bringing local relief to drought-stricken areas of the Nation's midsection. However, by the end of October the rains had not spread to the East and a severe drought continued in that area. Many new records were established for least October precipitation, lowest for any month, and longest period of consecutive rainless days.

Hurricane Flora, which devastated Haiti and Cuba in early October, was the most deadly tropical cyclone of recorded history in the Atlantic area. It is estimated that Flora took nearly 7,000 lives and caused nearly half a billion dollars property damage. Both Flora and Ginny, a later hurricane, moved erratically and at times threatened the southeastern States. Fortunately, neither reached the mainland, though Ginny was close enough to bring rainfall and gusty winds along the Atlantic Coast, and caused some property damage in Maine.

2. TEMPERATURE

The extent and intensity of the warm weather in October can be seen in figure 1 showing average temperature departures from normal for the United States. Negative departures are found only in northern California and the extreme Southeast, with the greatest positive departures in the North Central States. Departures exceeding 2 standard deviations were common in the latter area, reaching 3 standard deviations, a very rare event, at Duluth, Minn. (+11.9° F.).

Figure 2 shows the distribution of the numerous stations reporting highest October averages of record. Several stations in this area, including Wichita and Concordia, Kans., Minneapolis-St. Paul, Minn., and Rockford, Ill.,

were slightly warmer in October 1947. That month and the current one were remarkably analogous, with nearly identical temperature anomaly patterns and very similar height anomalies over the Gulf of Alaska and North America.

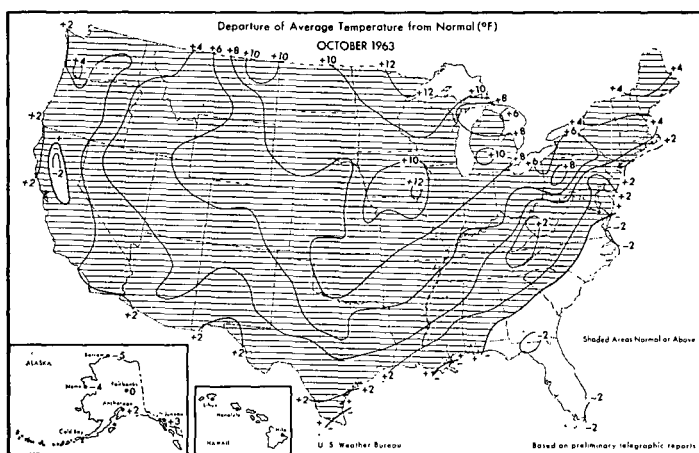


FIGURE 1.—Departure of average surface temperatures from normal (°F.) for October 1963 (from [3]). The month was notable for widespread warmth.

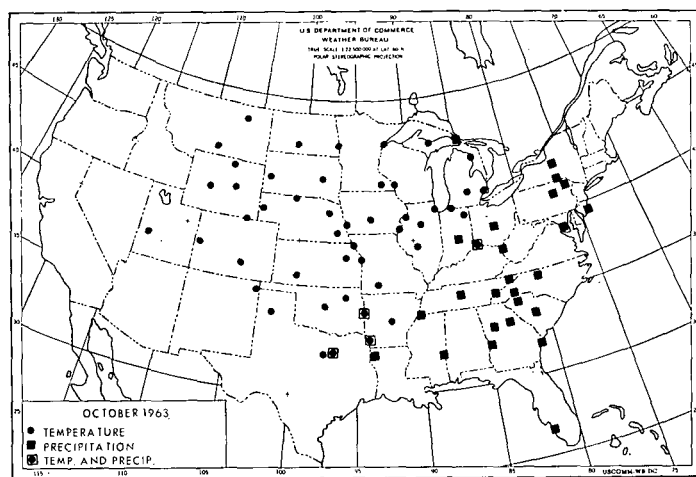


FIGURE 2.—Locations of stations reporting the highest average temperatures (dots) and least precipitation (squares) of record for October, in 1963.

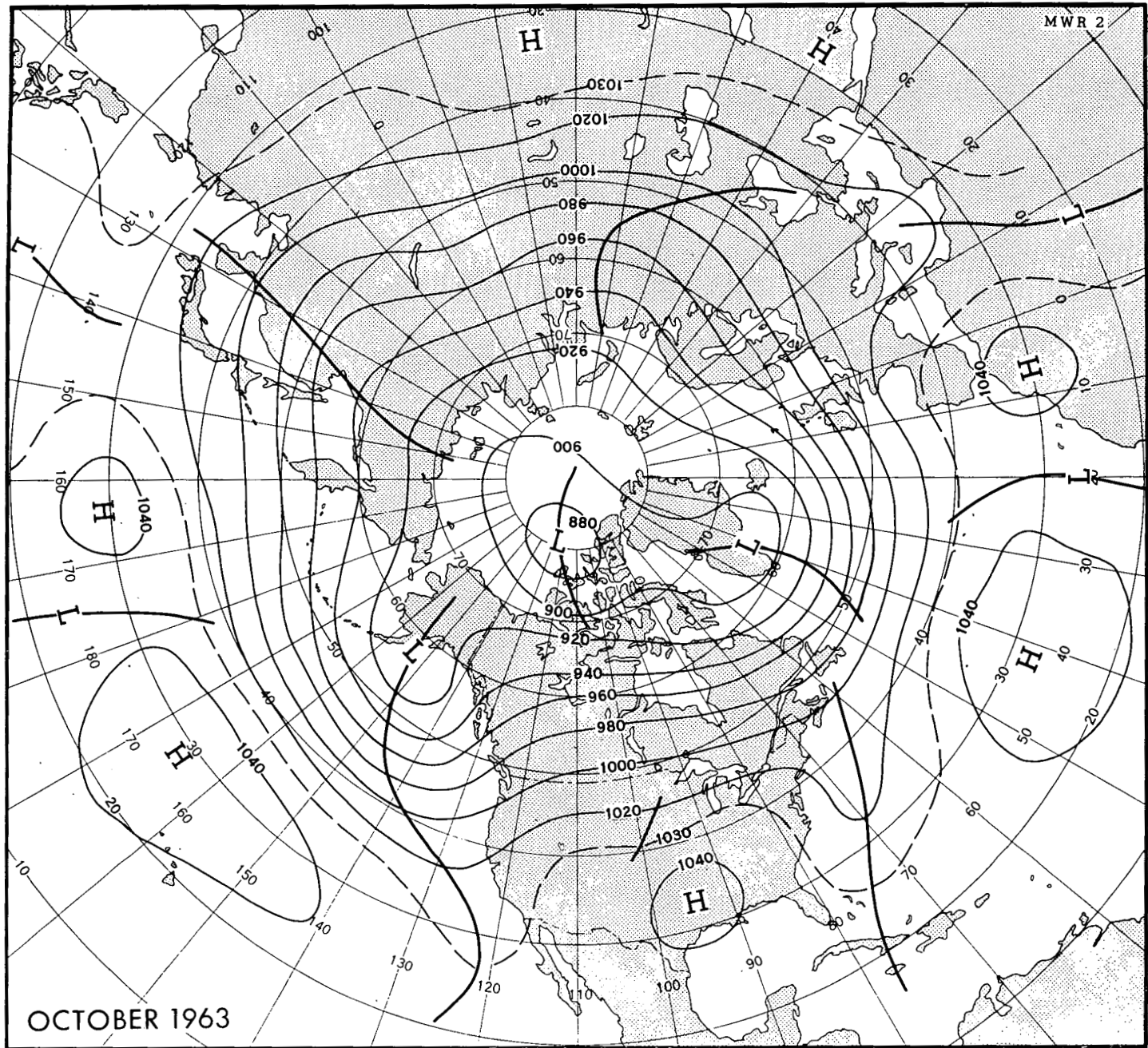


FIGURE 3.—Average 700-mb. contours for October 1963. Over North America fast westerlies in the north and an anticyclone in the south were associated with abnormal warmth and dryness in the United States.

When the temperature departures of October 1963 were placed in the usual class categories, it was found that the prevailing class was “much above”, except in the Far West and in coastal States from Maine to Texas. This is an extreme class which normally occurs one-eighth of the time. The Plains States were one temperature class warmer than in the previous month and the Northeast was four classes warmer.

Other temperature highlights included new record maxima for October (table 1) and for so late in the season at numerous stations from the Continental Divide to the Appalachians. The first of several heat waves reached

TABLE 1.—Stations reporting highest daily maximum temperature for any October in 1963

Station	Temperature (°F.)	Day of Month
Little Rock, Ark.....	97	10, 11
Grand Junction, Colo.....	88	1
Chicago, Ill.....	94	6
South Bend, Ind.....	92	6
Portland, Maine.....	88	7
Detroit, Mich.....	91, 92	6, 7
St. Joseph, Mo.....	97	10
Helena, Mont.....	85	3
Syracuse, N.Y.....	87	7
Huron, S. Dak.....	102	5
Green Bay, Wis.....	88	6
La Crosse, Wis.....	93	6
Madison, Wis.....	90	6
Milwaukee, Wis.....	89	6

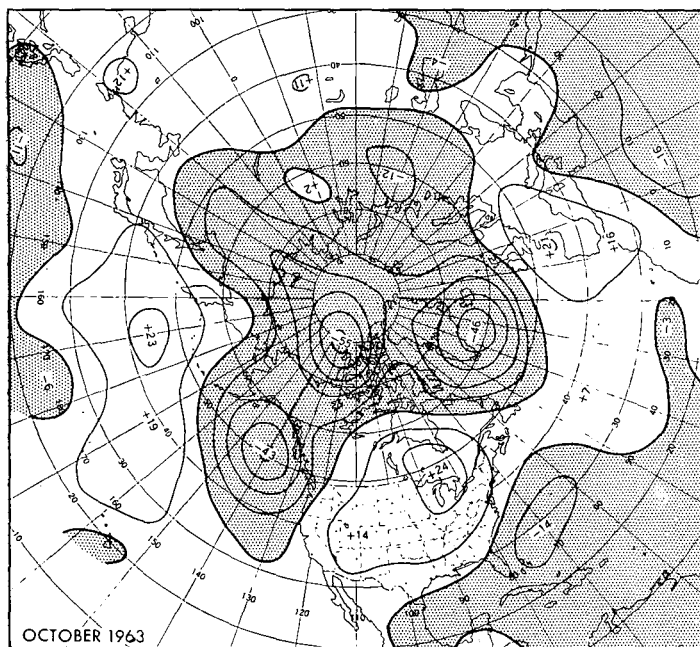


FIGURE 4.—Average 700-mb. height departures from normal (tens of feet) for October 1963. Dryness in the east was supported by the lack of anomalous flow components from the Gulf of Mexico.

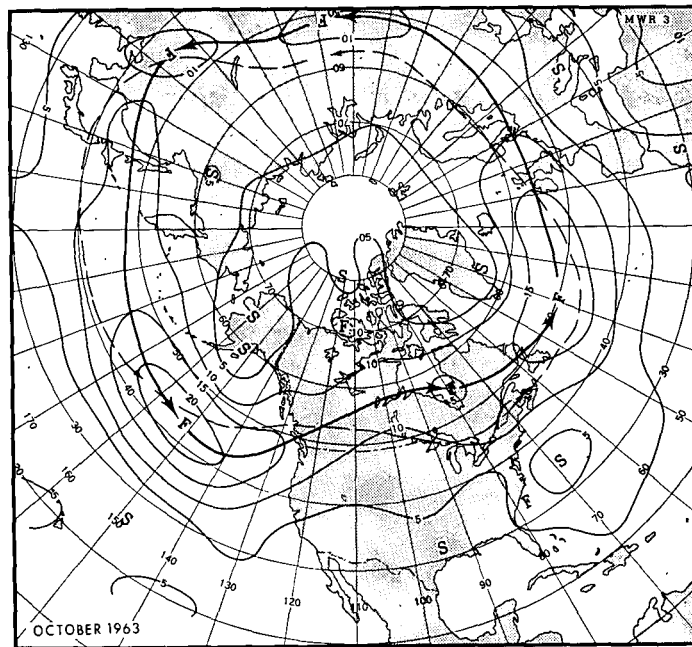


FIGURE 5.—Mean isotachs (m.p.s.) at 700 mb. for October 1963. Jet axis and storms were diverted northward from normal over North America.

maximum intensity on the 5th when Huron, S. Dak. reported 102° F., the first time the temperature had reached 100° F. this year. In North Dakota daily departures from normal were as much as $+25^{\circ}$ F. on the 5th and exceeded 20° F. during subsequent warm periods on the 13th and 22d.

In terms of daily departure, the final heat wave was the most intense and also extended farther east than its predecessors. During this spell the temperature on the 23d at Duluth, Minn. was 27° F. higher than normal, and on the 27th the departure at Boston, Mass. was $+23^{\circ}$ F.

Temperatures were below normal in the central and northern Plains States for the first time on the 27th, following passage of the month's strongest cold front. It was behind this front that the latest fall freeze of record occurred at Helena, Mont., Cheyenne and Sheridan, Wyo., and St. Cloud, Minn. The freeze brought to an end the longest growing season yet experienced at Bozeman, Mont. and Scottsbluff, Nebr. As the front and its associated upper trough intensified over the eastern States, cool Canadian air poured into the East and temperatures fell rapidly as far south as Miami, Fla. The minimum temperature at Tampa, Fla. on the 30th was 41° F., the coldest ever observed in October and so early in the fall.

The temperature pattern of figure 1 corresponded closely to the usual relationship of surface temperatures to mid-tropospheric circulation (fig. 3) and its anomaly (fig. 4). With a deep trough in the Gulf of Alaska and fast westerly flow across North America, the United States was flooded with warm Pacific air. The belt of

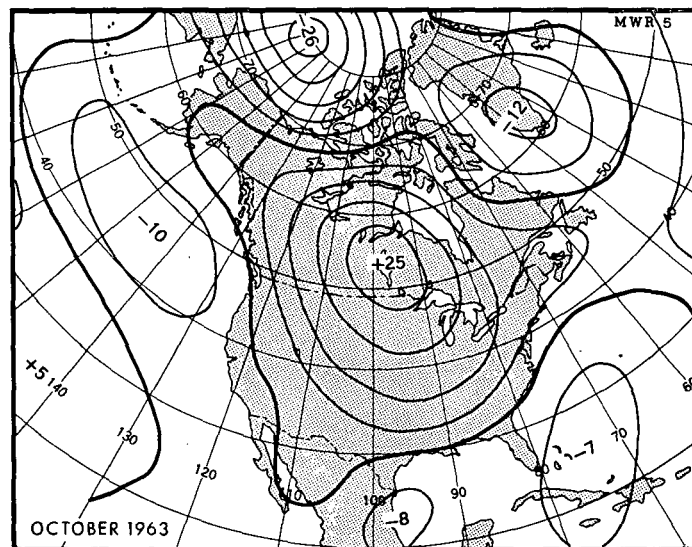


FIGURE 6.—Average departure from normal of thickness (700-1,000-mb.) (tens of ft.) for October 1963. Positive departures indicate warmer than normal surface temperatures over most of North America.

maximum west winds was north of its usual location over North America, as shown by the jet axis in figure 5, and Pacific storms which often bring outbreaks of cool Canadian air were similarly diverted. It was only in the Southeast that there was an appreciable northerly component of mean 700-mb. flow. Height values at 700 mb. averaged above normal over most of the United States (fig. 4), where the correlation with local surface temperature anomaly is markedly positive in general. In addi-

tion, mean 700-mb. heights were below normal in the Gulf of Alaska and Yukon areas where 700-mb. heights correlate negatively with surface temperature in the United States. These and other relationships are incorporated in the objective specification scheme devised by Klein [1] for obtaining surface temperatures given the 700-mb. pattern. It is interesting that the method, using mean 700-mb. height anomalies observed this October, specified even higher temperatures than were observed over more than half the country.

Figure 6 shows the distribution of the anomaly of 700–1000-mb. thickness which closely reflects surface temperature departures. From this distribution it is evident that unusually warm weather prevailed over most of North America. Below normal temperatures were limited to peripheral areas including western and northern Alaska (see also inset fig. 1), northern Canada, southeastern United States, and Mexico.

3. PRECIPITATION

The dryness of previous months [2] in the eastern half of the Nation reached record proportions in October and resulted in severe drought in many areas. Less than a tenth of normal October precipitation was measured in a wide band from Texas to the southern Appalachians, thence northeastward to New England (fig. 7A). Precipitation there totaled less than half an inch, and a number of stations recorded none at all. It was the first month without measurable precipitation at those stations listed in table 2. Many additional locations (fig. 2) experienced the least October precipitation of record over a wide area extending from Texas to New England, and the drought index ranged from severe to extreme (fig. 7B) over this band. Shortages of water and soil moisture worsened in that area, much of which had received only 20 to 50 percent of normal precipitation since the first of the year. The status of the drought was summarized at the end of the fourth week of October [3] and the following were noted: Parts of Kansas and much of Oklahoma were extremely dry. Drought was in the sixth week in Ohio and fourth week in Pennsylvania, and continued in the South. Danger of forest and brush fires was high in much of the drought area, and over 100 fires were reported in the New England woodlands during the fourth week. It can be seen (fig. 7) that the most extreme drought was not necessarily in the areas of least October rainfall. In Georgia, for example, October was the driest month of record, but precipitation had exceeded normal in the previous month and drought was therefore less severe.

TABLE 2.—*Stations reporting first month of record without measurable precipitation in October 1963*

Texarkana, Ark.	Meridian, Miss.
Washington, D.C.	Asheville, N.C.
Athens, Ga.	Knoxville, Tenn.
Atlanta, Ga.	Nashville, Tenn.
Columbus, Ga.	Huntington, W. Va.
Shreveport, La.	

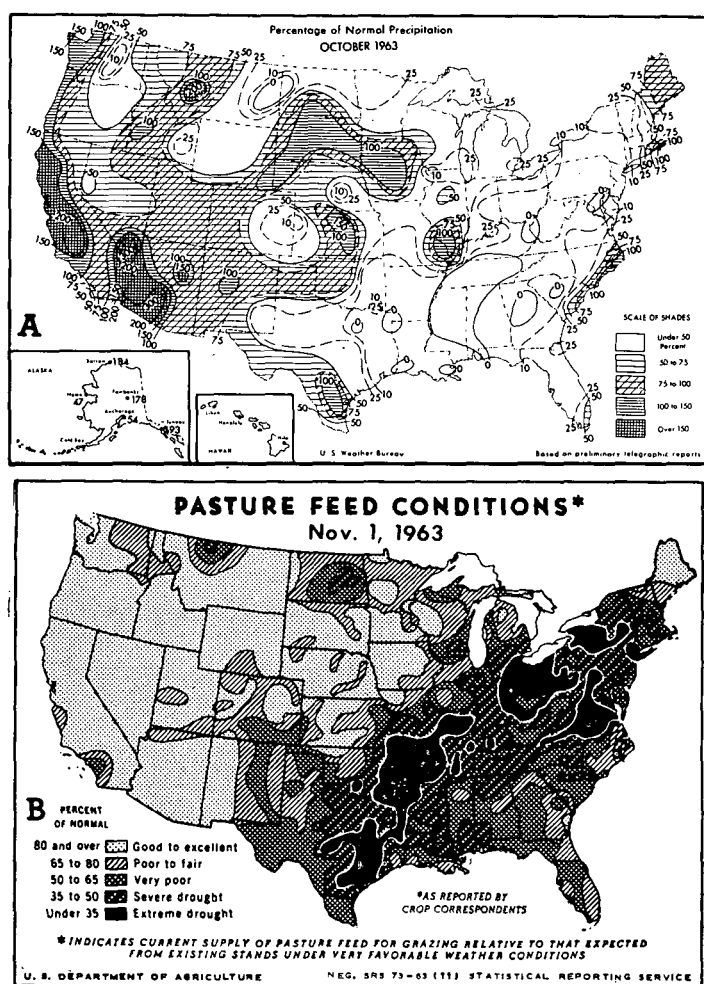


FIGURE 7.—(A) Percentage of normal precipitation for October 1963 (from [3]). Drought in the south and east was aggravated this month. (B) Pasture feed conditions on November 1, 1963. Drought was severe from Texas to New England (from [3]).

Dryness in the South and East is well indicated by the anticyclonic nature of the mean 700-mb. circulation (figs. 3 and 4). Average heights were well above normal, implying abnormal subsidence, and there was no component of anomalous flow from the usual moisture source (Gulf of Mexico). Also the Pacific storms were diverted northward away from the area, along the jet axis of figure 5. It is believed that the anticyclonic conditions may have been enhanced by a feedback mechanism through which drought tends to be self-perpetuating [4].

In other areas of the country the circulation was more favorable for precipitation. Moist southerly or southwesterly flow in the West brought above normal precipitation (fig. 7A) along the windward mountain slopes. Conspicuous areas of "rain shadow" appeared downslope from mountainous regions of the Pacific Northwest and the Rocky Mountains where the westerly flow was slightly stronger than normal.

Over the middle of the country the relationship of precipitation to the average circulation is less clear. There was, however, a weak component of southerly anomalous

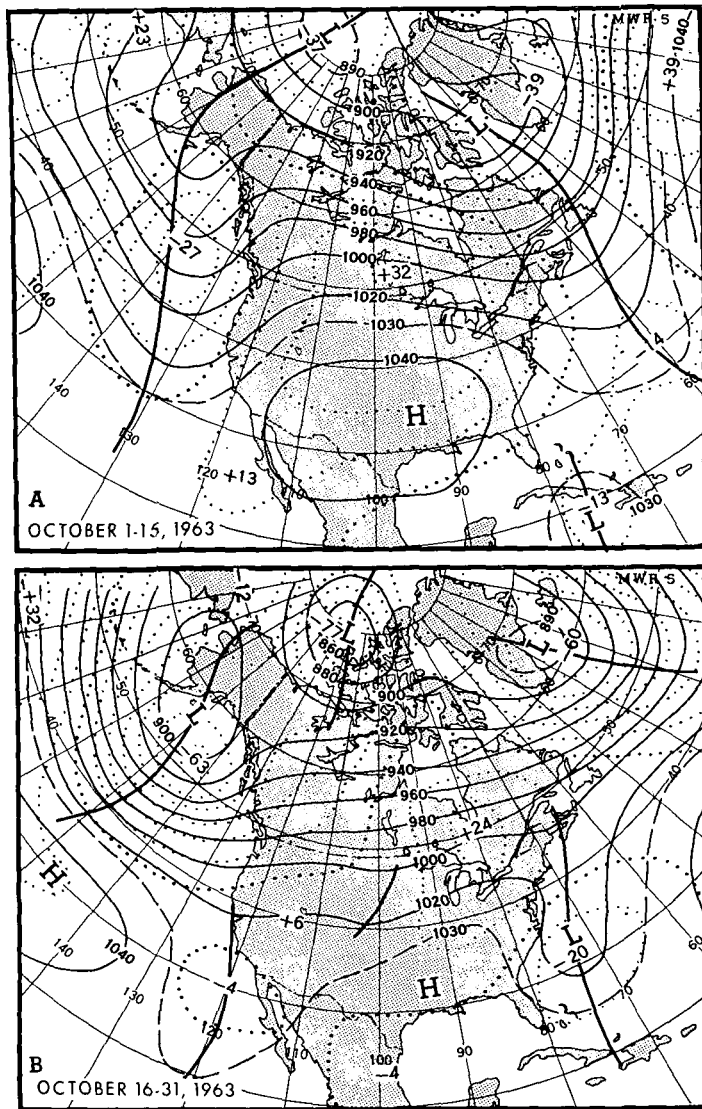


FIGURE 8.—700-mb. height (solid) and its departure from normal (dotted) in tens of feet for (A) October 1–15, and (B) October 16–31, 1963. Circulation became more cyclonic in the west during the last half of the month.

flow which accompanied a weak trough in the Northern Plains (figs. 3 and 4). The association becomes clearer when one considers the half-monthly circulation patterns shown in figure 8. Predominantly anticyclonic circulation over the West in early October shifted eastward during the last half of the month resulting in more cyclonic conditions with wetter, cooler weather in that area. Rainfall spread to the east coast soon after the end of October, finally ending the longest period of consecutive days (32) without measureable precipitation at Washington, D.C., since records began in 1871. Other stations with similar records were Albany, N.Y. (23), Cleveland, Ohio (27), Columbus, Ohio (48), and Knoxville, Tenn. (32 days).

4. CIRCULATION

An extraordinary feature of the mean 700-mb. circulation for October was the extensive and regionally intense

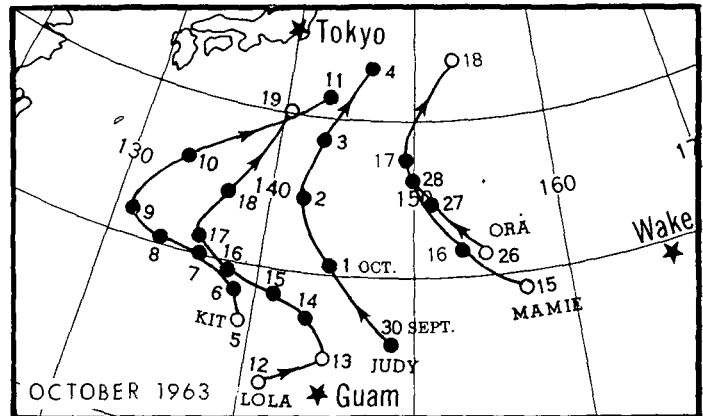


FIGURE 9.—Tracks of typhoons during October 1963. Circles and dates indicate 1200 GMT positions. Solid circles denote typhoon intensity, open circles tropical storm intensity.

area of negative height anomaly at higher latitudes (fig. 4) associated with an expanded circumpolar vortex and westerlies well above normal. The central departure (–550 ft.) in the deep polar Low has been matched only once (1938) in 30 previous Octobers of available record. Other very intense height anomaly centers in figure 4 were associated with deep mean troughs in the Gulf of Alaska and near Greenland. Strong positive anomalies appeared over the western Pacific, North America, and Europe. Thus, excepting the region of confluence over northern Canada (fig. 4), the wave pattern north of the subtropics was abnormally amplified, with anomalies negative in the troughs and positive in the ridges. The Asiatic coastal trough extended unusually far northward and the deep Pacific trough was east of its normal position. With strong westerlies in the zone of confluence, the Canadian section of the trough normally found in eastern North America was sheared from the southern part and displaced well out into the Atlantic. This trough and the ridge over western Europe provided a warm circulation regime for most of Europe.

Negative height anomalies in polar regions, surrounded by a continuous positive band, reflected the faster than normal west winds observed at higher latitudes. The anomalies of average wind speed in the western sector of the hemisphere were +1.6 m.p.s. in the polar region and +1.0 m.p.s. in the temperate region. By way of compensation, the subtropical westerlies averaged 0.9 m.p.s. below normal.

The belt of maximum west winds (jet, fig. 5) was farther north than usual except over Eurasia and through the deep mean trough in the eastern Pacific. The westerlies averaged faster than normal by as much as 9 m.p.s. in the eastern Pacific trough and by more than 5 m.p.s. from Hudson Bay to Great Britain.

The below-normal average speed of the subtropical westerlies was reflected in the distribution of positive 700-mb. height anomalies over the oceans, especially in the Pacific where the subtropical Highs were abnormally

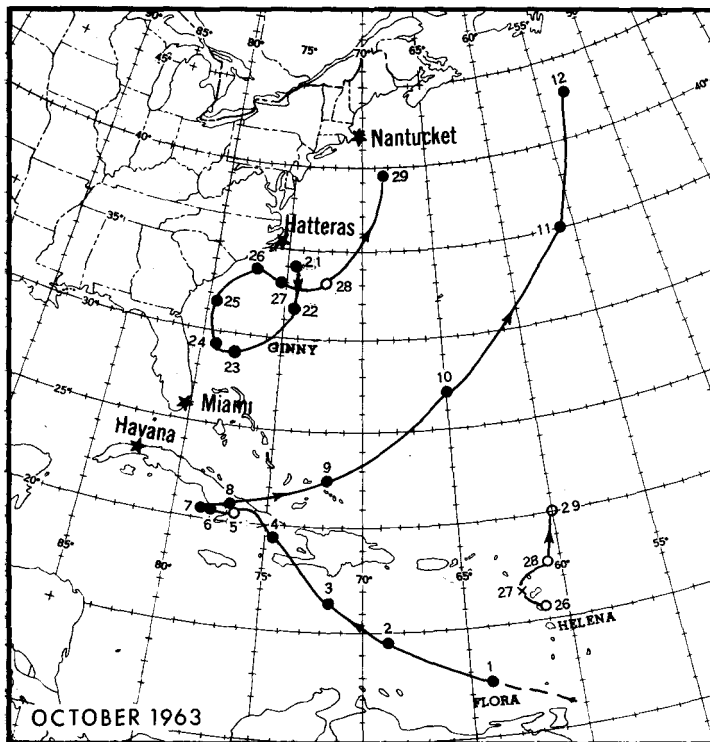


FIGURE 10.—Preliminary tracks of Atlantic hurricanes and tropical cyclones during October 1963. Circles and dates indicate 1000 GMT positions. Solid circles denote hurricane intensity and open circles tropical storm intensity. Helena was a tropical depression on the 27th. The paths of Flora and Ginny were extremely unusual.

strong. The long fetch of easterly anomalous flow along the northern edge of the Tropics and subnormal heights within the Tropics west of 180° long. constituted a favorable climate for the rather frequent occurrence of typhoons (see fig. 9), most of which followed typical paths, curving northward around the western end of the subtropical High from a deep mean trough.

5. ATLANTIC HURRICANES

Three tropical storms were observed in the Atlantic during October, tracks of which are shown in figure 10. Of the three, Flora and Ginny reached hurricane intensity. Flora was unusually destructive. In fact, Flora took more lives (6792 by latest estimate) than any previously recorded tropical cyclone in the Atlantic area, including the historic Galveston hurricane of 1900. The storm reached its maximum intensity just before crossing Haiti (fig. 10) where it caused flash floods and landslides which

washed away or buried portions of towns, and cost an estimated 5000 lives. The highest measured wind on Haiti was 120 m.p.h. In Cuba, where 1750 lives are believed lost, winds of 70 to 100 m.p.h. lashed eastern sections for 100 or more hours. In a 12-hr. period on October 3-4, 16 in. of rain fell at Morne Macaya, Haiti. The storm total at Silver Hill, Jamaica was more than 60 in.

A conservative estimate of property damage attributable to Flora is \$488,550,000, with some areas of Hispaniola still to be heard from. Damage to the economy of the areas worst hit is more difficult to estimate but the effects of Flora will surely be felt for years.

Hurricane Flora originated in the Tropics and remained imbedded in the tropical easterly flow for several days until it became blocked near eastern Cuba by high pressure areas to the west, north, and east. After spending nearly 5 days in the vicinity of eastern Cuba, it was picked up by westerlies in a polar trough and carried northeastward into the Atlantic.

Hurricane Ginny formed in the cut-off southern section of a shearing mean trough. The storm began as a cold Low and gradually assumed tropical characteristics over warm waters of the Gulf Stream at about 34° N. This storm was forced southwestward (fig. 10) by a strong ridge moving eastward over New England and the Maritime Provinces (fig. 8B). The positive height anomaly center in the ridge shifted rapidly to Davis Strait near the end of the month and Ginny then moved swiftly northeastward. The storm grazed New England on the 29th with gusts up to 76 m.p.h. at Nantucket, Mass., and some wind damage at Portland, Maine. While there were also reports of beach erosion, hurricane Ginny was undoubtedly more beneficial than destructive, since rainfall from the storm along the coasts of the Carolinas and New England ended long dry spells in both areas.

REFERENCES

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2. J. F. O'Connor, "The Weather and Circulation of July, August, and September 1963—Dry and Cool in the East," *Monthly Weather Review*, vol. 91, Nos. 10-12, Oct.-Dec. 1963, pp. 737-748.
3. U.S. Weather Bureau, *Weekly Weather and Crop Bulletin*, *National Summary*, vol. L, Nos. 43, 44, 46, Oct. 28, Nov. 4, and Nov. 18, 1963.
4. J. Namias, "Factors in the Initiation, Perpetuation, and Termination of Drought," *Proceedings of Commission of Surface Waters, General Assembly, IUGG, Helsinki, 1960*, Association of Scientific Hydrology Publication No. 51, 1960, pp. 81-94.

Revision of Monthly Temperature Charts On Back of Daily Weather Map

The charts entitled "Average Daily Maximum Temperature," "Average Daily Minimum Temperature," "Average Daily Temperature," and "Average Daily Range of Temperature" which have appeared each month on the back of the *Daily Weather Map* for over 15 years are being revised. The new charts are based on the 30-year normals, 1931-60, and will be entitled "Normal Daily Maximum Temperature," etc. It is recommended that the old charts be discarded as the new ones become available.